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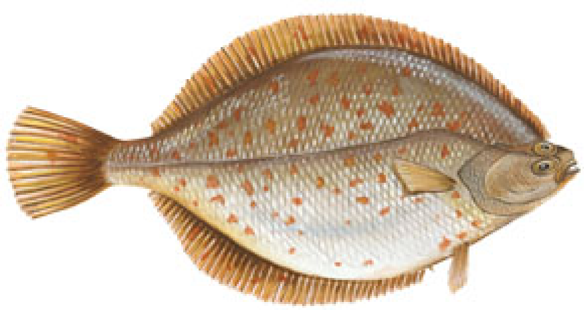
Gulf Region

Canadian Science Advisory Secretariat
Science Advisory Report 2016/033

STOCK ASSESSMENT OF YELLOWTAIL FLOUNDER (*LIMANDA FERRUGINEA*) OF THE SOUTHERN GULF OF ST. LAWRENCE (NAFO DIV. 4T) TO 2015



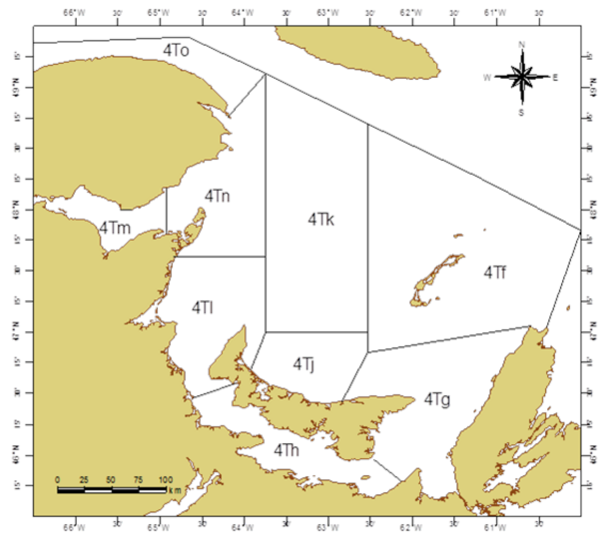


Figure 1. Subdivisions within NAFO Div. 4T in the southern Gulf of St. Lawrence.

Context:

Yellowtail flounder (Limanda ferruginea) range from southern Labrador to Chesapeake Bay (Scott and Scott 1988). In the southern Gulf of St. Lawrence (NAFO Div. 4T), Yellowtail tends to be distributed in shallow, near shore areas where it has been fished primarily for bait. The main fishery for Yellowtail flounder now occurs in the waters off the Magdalen Islands. The first assessment of this stock was in 1997 with subsequent assessments and updates in 2002 (Poirier and Morin 2002), 2005 (DFO 2005), 2013, and 2014 (DFO 2015). An annual total allowable catch (TAC) of 300 t for Yellowtail flounder has been in effect since 2000 in NAFO Div. 4T. DFO Ecosystems and Fisheries Management has instituted a multi-year management approach for Yellowtail flounder and requested advice for a TAC decision for May 2016 to May 2021 for the southern Gulf of St. Lawrence Yellowtail flounder stock.

This Science Advisory Report is from the February 29 and March 1, 2106 science peer review meeting on the stock status of Yellowtail flounder and the development of management advice for the fishery on this stock. Participants at the meeting included DFO Science (Gulf, Newfoundland and Labrador regions), DFO Fisheries Management (Gulf, Quebec regions), and the fishing industry.

SUMMARY

- Yellowtail flounder is currently caught in a relatively small directed fishery concentrated around the Magdalen Islands with landings less than 200 tonnes over the past 14 years.
- There has been a decrease in the size distribution of the Yellowtail flounder stock with percentages of fish ≥ 25 cm (minimum size limit for the fishery) decreasing from an average of 90% before 1990 to 19% by 2011, with a slight increase to 41% in 2015.
- Based on a population model, natural mortality on larger and older Yellowtail is estimated to have increased from 22% annual mortality during 1985 to 1990 to 86% in 2009 to 2015. In contrast, natural mortality on small and young Yellowtail is estimated to have declined from 53% annually in 1985 to 1990 to 16% to 21% since 1997.
- Based on a population model, the spawning stock biomass (SSB) is estimated to be higher in the past decade than in the mid to late 1980s but the percentage of the SSB composed of larger and older (7+ years) fish has declined from 40% in 1985 to 1990 to less that 0.5% since 2013.
- Fishing mortality is estimated to be generally low and of such a small proportion of the estimated total mortality of Yellowtail flounder that there is no perceived difference in stock trends over the next five years at catch projections of 0 t, 100 t, and 300 t annually. SSB declined slightly over the period in all cases. At the scale of the southern Gulf of St. Lawrence, natural mortality appears to be the dominant factor affecting stock status.
- A limit reference point (B_{lim} = 1.06 kg per tow) was derived from the biomass index of large Yellowtail flounder (≥ 25 cm) from the September Research Vessel survey. The stock is considered to have been in the critical zone since 2006, and the index in 2015 was 61% of B_{lim}.
- From the population model, the SSB has not changed like the large Yellowtail index used to define the reference point. However, the SSB is now composed primarily of fish less than 25 cm (72 %). This is an important consideration as there is an assumed greater value to reproductive potential of larger animals in the population.
- The contraction in size structure of Yellowtail flounder, the large decline in the estimated size at 50% maturity, and the decline in abundance indices of the previously abundant commercial sized group are consistent with a stock experiencing very high levels of mortality.

INTRODUCTION

Yellowtail flounder (*Limanda ferruginea;* henceforth referred to as Yellowtail) is a relatively small flatfish. Asymptotic mean length from southern Gulf of St. Lawrence sampling is 36 cm and the maximum size of Yellowtail sampled from the research vessel surveys dating to 1971 was 45 cm. It is relatively short lived with a maximum age estimated from samples of 13 years old. It is primarily distributed in shallow waters in the summer, at depths less than 50 m.

The last full assessment of the Yellowtail flounder stock in the southern Gulf of St. Lawrence (sGSL; NAFO Div. 4T) was completed in 2002 (DFO 2002; Poirier and Morin 2002). A review of size at maturity and size characteristics of the catches in the fishery in the Magdalen Islands was conducted in 2010 (DFO 2010). An update of status was provided in 2005 (DFO 2005) and indicators of abundance were provided in 2013 and 2014 (DFO 2014; DFO 2015).

The Fisheries

The time series of reported landings for Yellowtail in the sGSL begins in 1960 (Fig. 2). Before 1985, a considerable portion of flatfish landings was not identified to species and the landings identified as Yellowtail are considered incomplete (Fig. 2). In 1991, it became a license condition for mobile gear captains to maintain a logbook.

Yellowtail in the sGSL has been fished primarily for bait, except for 1997 when landings of 800 t were reported to supply a Japanese food market. Subsequent to that in 2000, a 300 t quota was established and has remained in effect. Preliminary landings for sGSL Yellowtail in 2015 were 102 t, near the low levels (82 to 86 t) that were recorded in 2013 and 2014 (Fig. 2). It is now fished exclusively for bait to supply the lobster fishery.

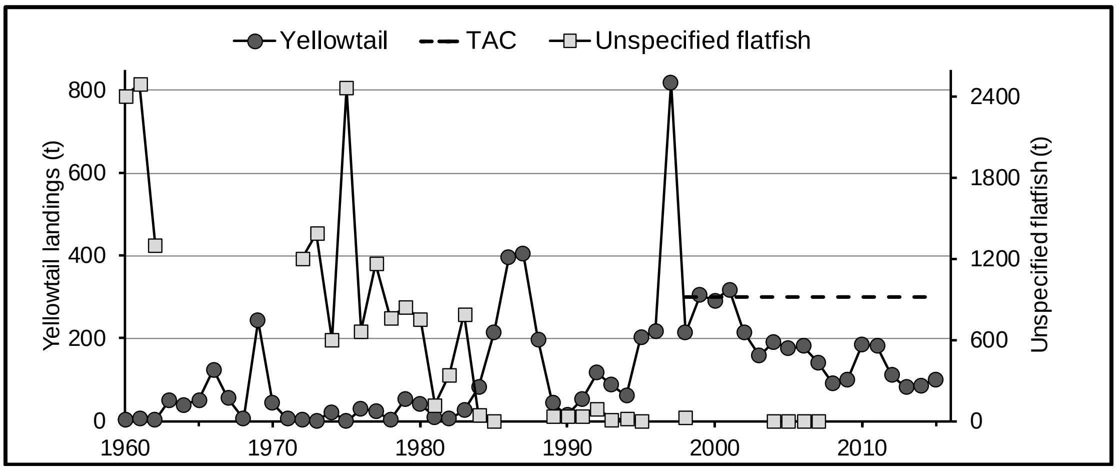


Figure 2. Recorded landings (t) of Yellowtail flounder and unspecified flatfish in NAFO Div. 4T, 1960 to 2015. The TAC of 300 t which has been in place since 1998 is also shown.

Until the mid-1990s, Yellowtail catches were from the Magdalen Islands (unit area 4Tf), northern PEI (unit are 4Tj), in Chaleur Bay and, until 2005, off eastern PEI and in the Shediac Valley (4Tg and 4Tl) (Figs. 1, 3). The fishery has been increasingly dominated by boats originating from the Magdalen Islands with catches concentrated in NAFO unit area 4Tf since 1997 (Figs. 3, 4). In the 1980s and 1990s, Yellowtail landings were reported mainly from August to November but since then, most landings have occurred in May to June, although in 2015 a third of landings were made in July (Fig. 3). The shift to early fishing coincided with the concentration of Yellowtail fishing off the Magdalen Islands where the spring lobster fishery requires an early supply of bait.

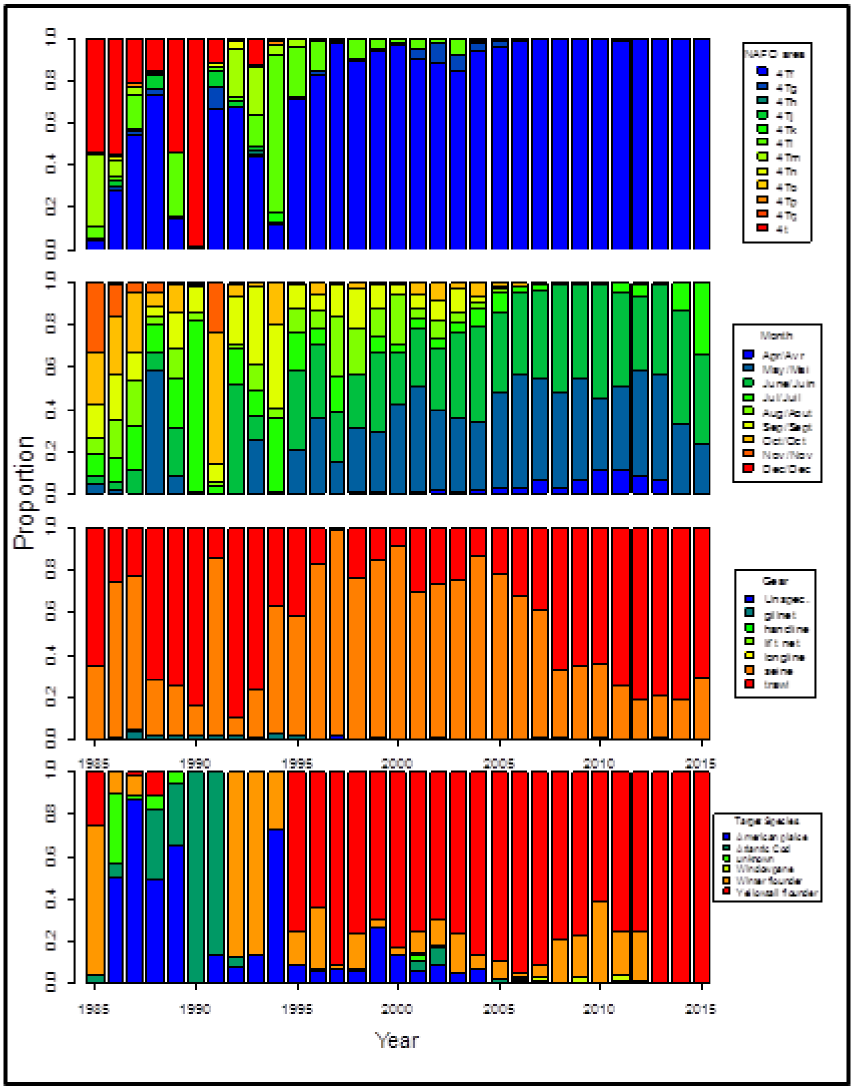


Figure 3. Proportion of annual Yellowtail landings by NAFO 4T subdivision (upper row), by month (second panel), by type of fishing gear (third panel) and by target fishing species (lower panel), 1985 to 2015.

Trawls and seines are the preferred gear type for fishing Yellowtail and the proportion of landings of each type has varied considerably through the years (Fig. 3). Until 2006, the seine fleet contributed most of the Yellowtail landings but since then, trawlers have been dominant, contributing roughly 70% to 80% of landings since 2011. Until the late 1990s, whenever the targeted species was indicated, Yellowtail was caught mainly as by-catch in fisheries directing for American plaice and Winter flounder. However, since the mid-1990s, Yellowtail has been increasingly reported as the targeted species (Fig. 3).

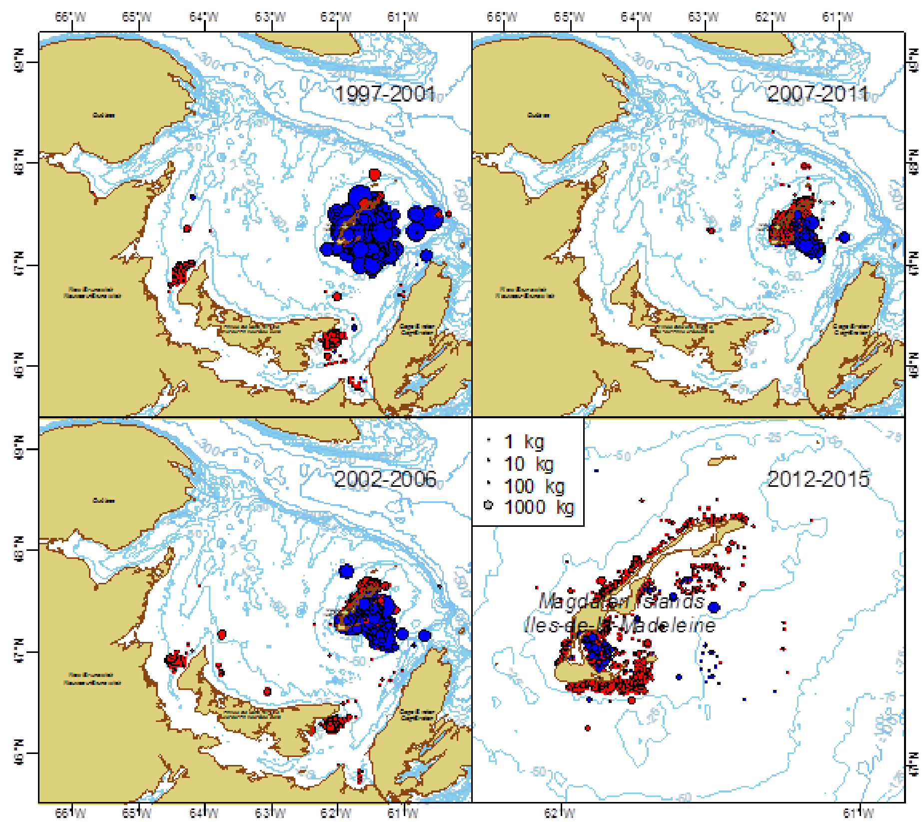


Figure 4. Spatial distribution of logbook catches of Yellowtail flounder by block of years and fishing gear type (trawl = red, seine = blue) from the southern Gulf of St. Lawrence, 1997 to 2015. The surface area of the plotted circle is proportional to the reported catch.

The size limit for Yellowtail in the sGSL 4T fisheries has been 25 cm since 1995 and is intended to be used with a small fish protocol. This protocol was not broadly applied in the past and samples of Yellowtail catches show a large increase in catches of smaller fish beginning in 1998, with the proportion of catches below 25 cm peaking at about 80% in 2010 to 2012. The increasing proportions of small fish occurred in both seine and trawl gears but the proportion of small fish declined in seines but remained higher in commercial trawlers since 2010. There was a modal shift from 31 cm in the late 1980s, to 28 to 29 cm in the late 1990s, to 25 cm in the late 2000s (Fig. 5). In 2014 and 2015, a new measure has been instituted in the Magdalen Island fishery requiring the return to the water (discarding) of Yellowtail less than 23 cm.

The focus on bait was important in the development of the Yellowtail fishery in the sGSL. From 2001 to 2012, an experimental bait fishery prosecuted mainly by small lobster boats fishing inshore with otter trawls targeting Yellowtail flounder, Winter flounder and Windowpane took place in the Magdalen Islands. The effort for this fishery increased rapidly from 19 active vessels in 2001 catching about five t of Yellowtail (6% of the local fishery landings) to 36 trawlers with bait licenses by 2008 with reported catches of 16 t, and peaked in 2010 (96 trawlers; 72 t) and 2011 (99 trawlers; 62 t). The experimental bait fishery was closed after 2012 and the bait market is now supplied by the commercial fishing fleet on the Magdalen Islands.

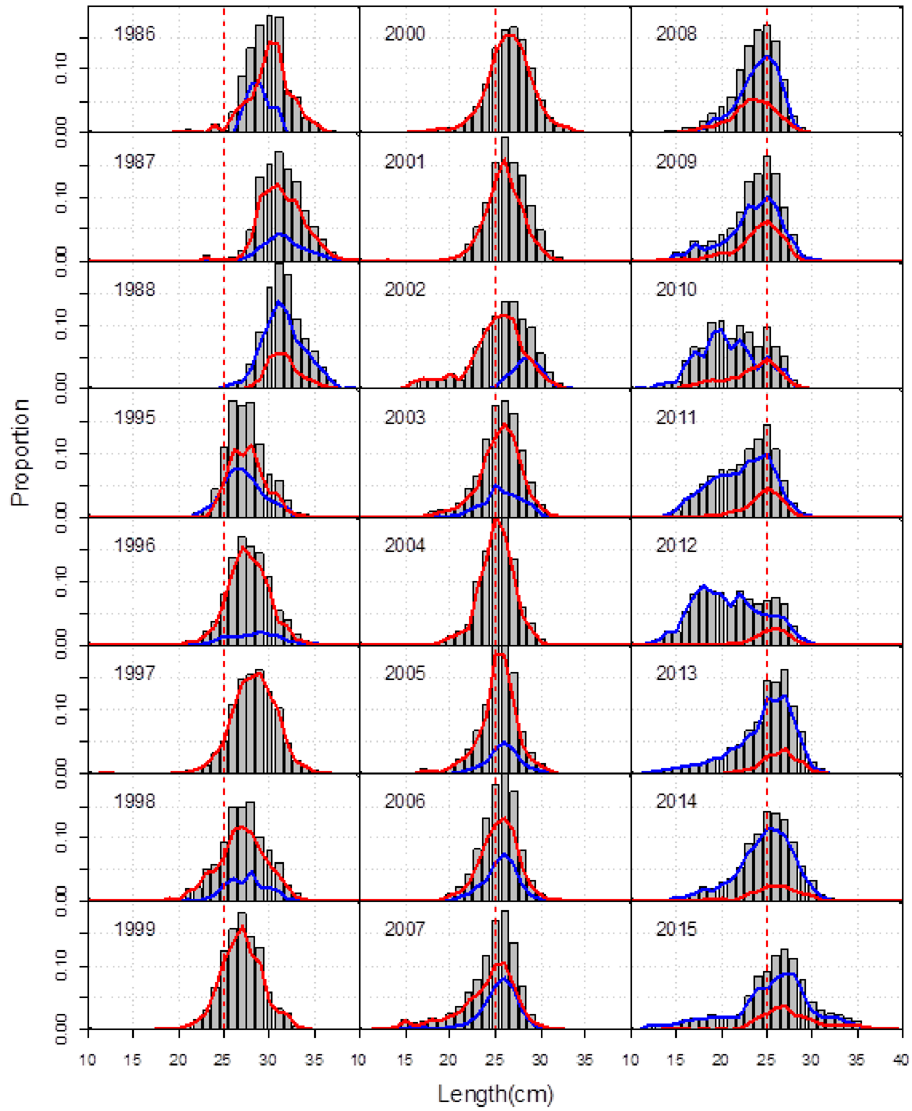


Figure 5. Proportions at length of Yellowtail flounder for the commercial fishery catches based on port and at-sea samples from the southern Gulf of St. Lawrence, for available years 1986 to 2015. The red dashed vertical line corresponds to the 25 cm size limit. Overlaid solid lines indicate the proportions of the total represented by trawler (blue) and seiner (red) catches. Note that for certain years, no trawl samples were available (e.g. 1999 to 2001). For 2014 and 2015 only, the size distribution are primarily from observer sampling of the catches prior to discarding of fish < 23 cm and therefore may not be representative of the true landed size distribution.

ASSESSMENT

Abundance Indices

An annual multi-species bottom trawl research vessel (RV) survey has been conducted in the sGSL using standardized protocols each September since 1971. In addition, a sentinel August otter trawl survey has been conducted since 2003. Results of these surveys provide information on trends in abundance and biomass for groundfish species in the sGSL.

The September RV survey of the sGSL follows a stratified random sampling design. The same stratification scheme has been used since 1971, except for the addition of three inshore strata (401-403) in 1984, which were not included in the following results to have a constant survey area over the entire time series. Comparative fishing experiments were conducted to test for species-specific changes in fishing efficiency whenever there was a change in research vessel (1985, 1992, and 2004/2005) or trawl gear (1985). Furthermore there was a change from day-only to 24-hr fishing in 1985, and both comparative fishing experiments and analyses of survey catches have been undertaken to estimate any species-specific changes in fishing efficiency that resulted from this change in protocol. When a change in fishing efficiency was detected for a particular species, catch rates for that species were standardized to a constant level of efficiency so that indices remained comparable for the entire time series (Benoît and Swain 2003; Benoît 2006).

The RV survey biomass index for small Yellowtail (< 25 cm) increased greatly from the mid-1980s to the mid-2000s and has remained high since then (Fig. 6). In contrast, the biomass index for large Yellowtail (≥ 25 cm) decreased sharply from the mid-1990s to 2012. This index increased in 2013 to 2015 but remained near the record low 2012 level (Fig. 6).

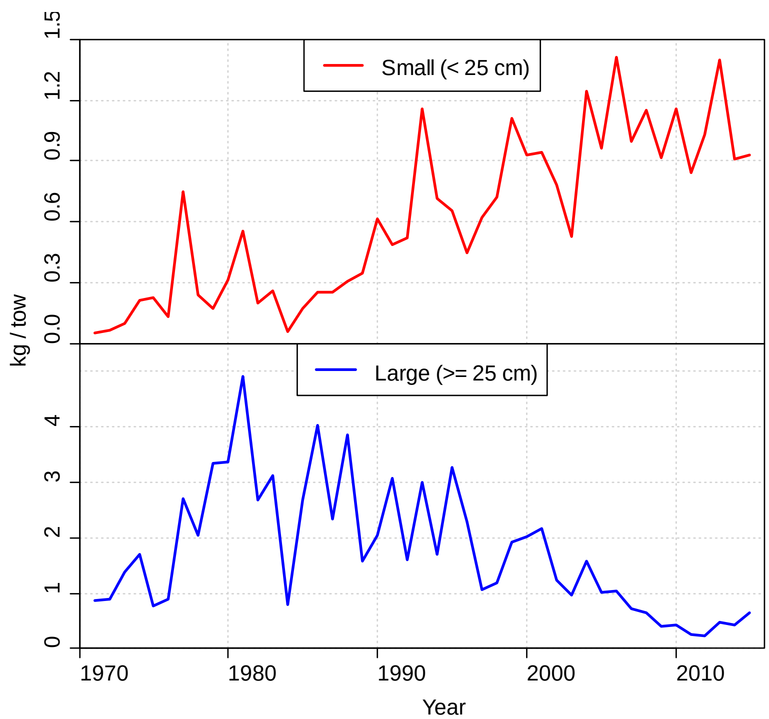


Figure 6. RV survey biomass indices (mean weight in kg per tow) for Yellowtail flounder with lengths < 25 cm (top panel) and ≥ 25 cm (bottom panel) from the southern Gulf of St. Lawrence, 1971 to 2015.

Length frequencies from the RV survey show a marked reduction in the sizes of Yellowtail captured (Fig. 7). Modal lengths were at 29 cm during the early portion of the survey (1971 to 1990) and began declining during the early 1990s to attain 24 cm in the early 2000s and decreased further to 22 cm in the past five years. Annual length-frequency distributions for the past five years show no obvious changes, with the modal length and standard deviation remaining fairly stable. The proportion (by number) of Yellowtail ≥ 25 cm has decreased from 90% in the 1970s to the present level of less than 40% (Fig. 8).

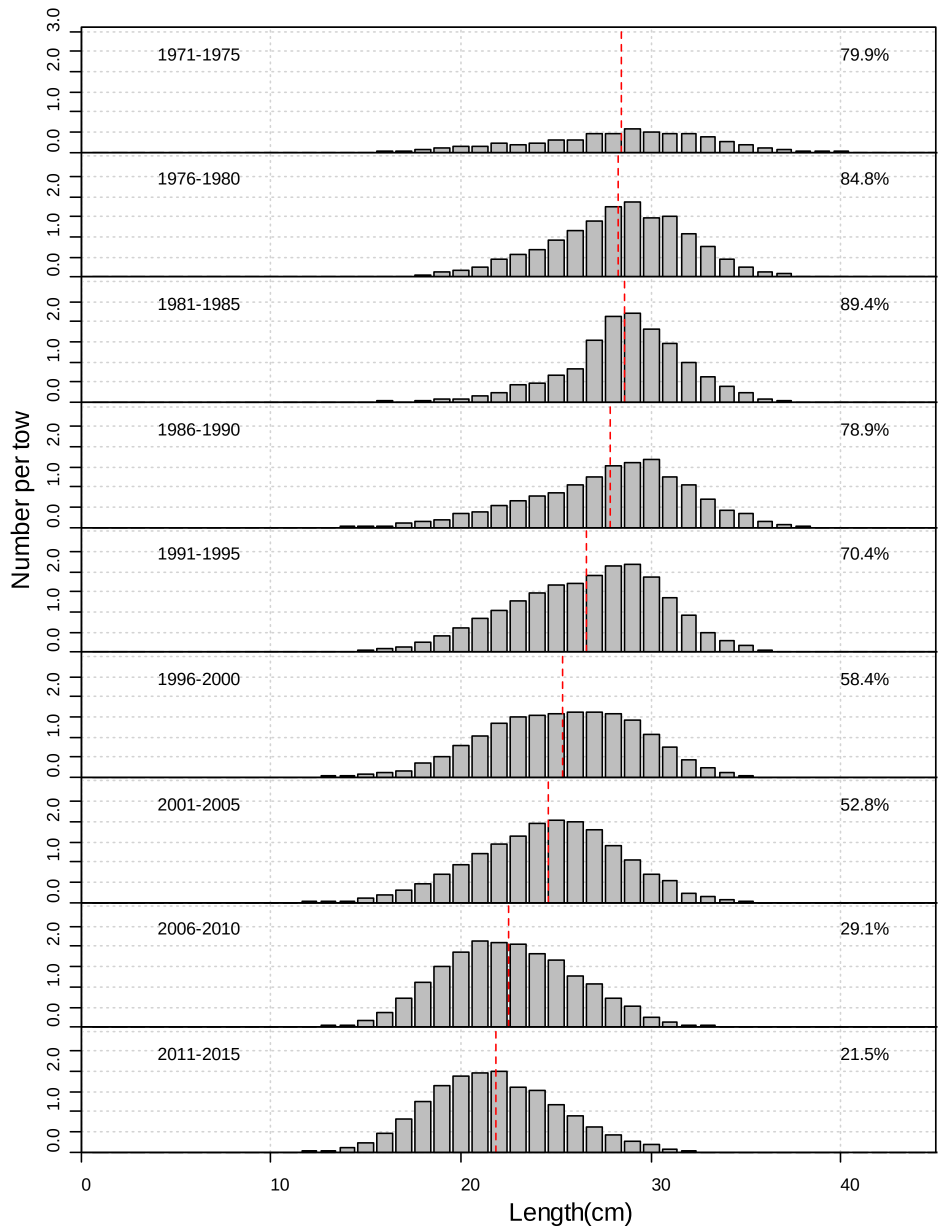


Figure 7. RV survey length frequencies in number per tow of Yellowtail flounder from the southern Gulf of St. Lawrence in five year groups, 1971-2015. The dashed vertical red line shows the mean length for each period.

The main fishery for Yellowtail occurs in the waters around the Magdalen Islands. Due to the importance of this local fishery, a separate index was produced for the RV survey strata (428, 434, 435 and 436) for this area. Similar to the sGSL index, the biomass of Yellowtail < 25 cm increased sharply from the late 1980s to the mid-2000s whereas biomass of large Yellowtail (≥ 25 cm) dropped sharply between the mid-1990s and late 2000s in this area. The biomass of large Yellowtail was at the lowest level in 2007. Since then, there has been a slight increase but the index remains near the record low level. The trend in size of Yellowtail for the Magdalen Islands strata is very similar to that of the sGSL, with the shift in modal size occurring mainly during the 1990 to 2010 period associated with a decline in abundance of large Yellowtail (≥ 25 cm) in the survey catches (Fig. 8).

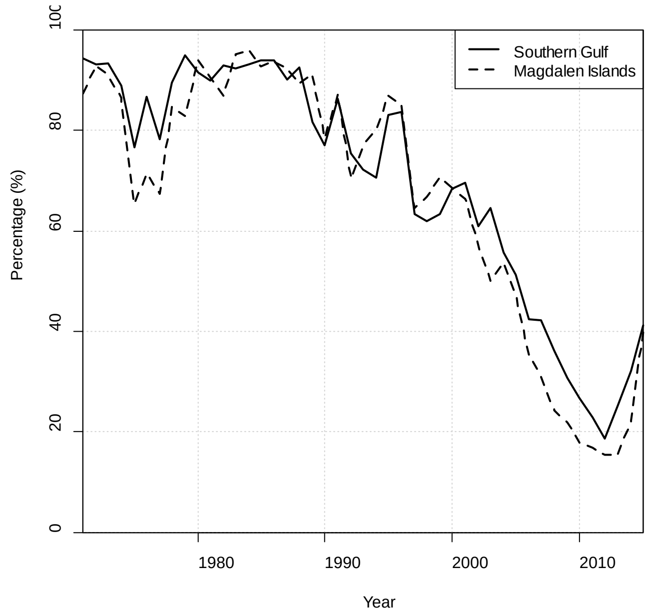


Figure 8. Percentages, based on standardized length-frequencies of the catch, of Yellowtail flounder of length ≥ 25 cm in the September bottom trawl survey catches, in all strata of the southern Gulf of St. Lawrence (solid line) and in the strata around the Magdalen Islands (dashed line), 1971 to 2015.

The size-at-maturity, the fish length at which 50% of fish are mature, was estimated for each year and sex from the RV survey observations (Fig. 9). There has been a decreasing trend in size-at-maturity of Yellowtail with size-at-maturity of 23 to 24 cm during the 1970s decreasing to 14 to 15 cm for females and 12-13 for males in recent years.

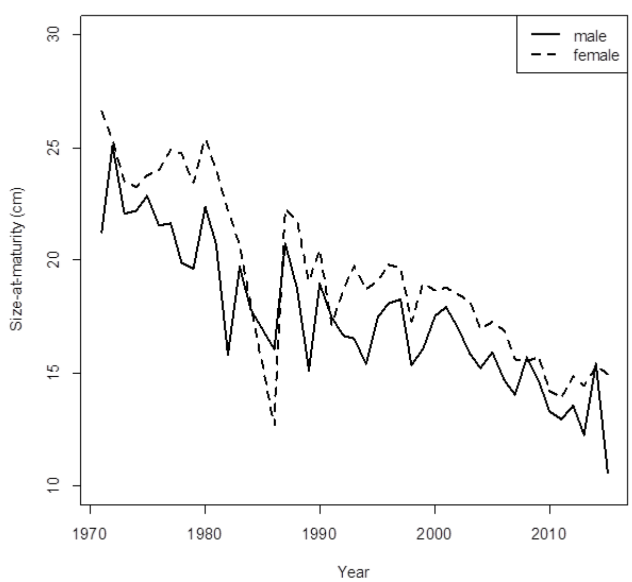


Figure 9. Size (cm) at 50% maturity of Yellowtail flounder, by year and sex, from the southern Gulf of St. Lawrence as estimated from samples collected from the RV survey, 1971 to 2015.

Spatial Distribution

The spatial distributions of standardized Yellowtail catches (in kg per tow) from the RV survey are shown in Figure 10. Yellowtail are distributed along the mid-shore area throughout the sGSL. Smaller catches have become more prevalent (20% of total catches) in the deeper (50 to 65 m depth) part of the sGSL since 1996 in contrast to the period from 1971 to 1995 when there were no catches at those depths. While the depth profile of stations sampled shows no variation over time, there are greater proportions of the total catches of Yellowtail taken in deeper (50 to 65 m) and cooler waters (< 10ºC) since 2000 (Fig. 11). The scale of catches has decreased in all areas, though some mid-sized catches still occur in northern PEI and to the east of the Magdalens.

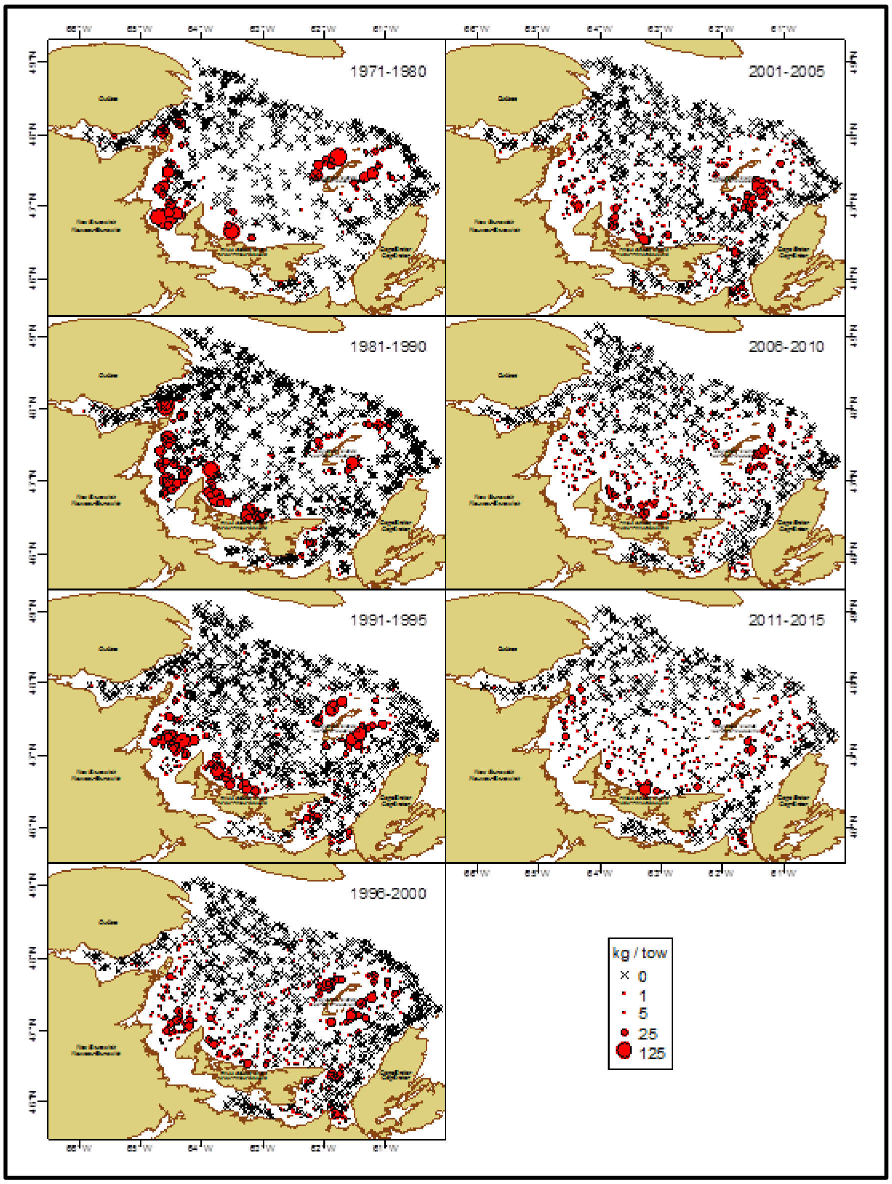


Figure 10. Spatial distribution of standardized September bottom trawl survey catches (in kg per standard tow) of Yellowtail flounder in the southern Gulf of St. Lawrence, 1971 to 2015.

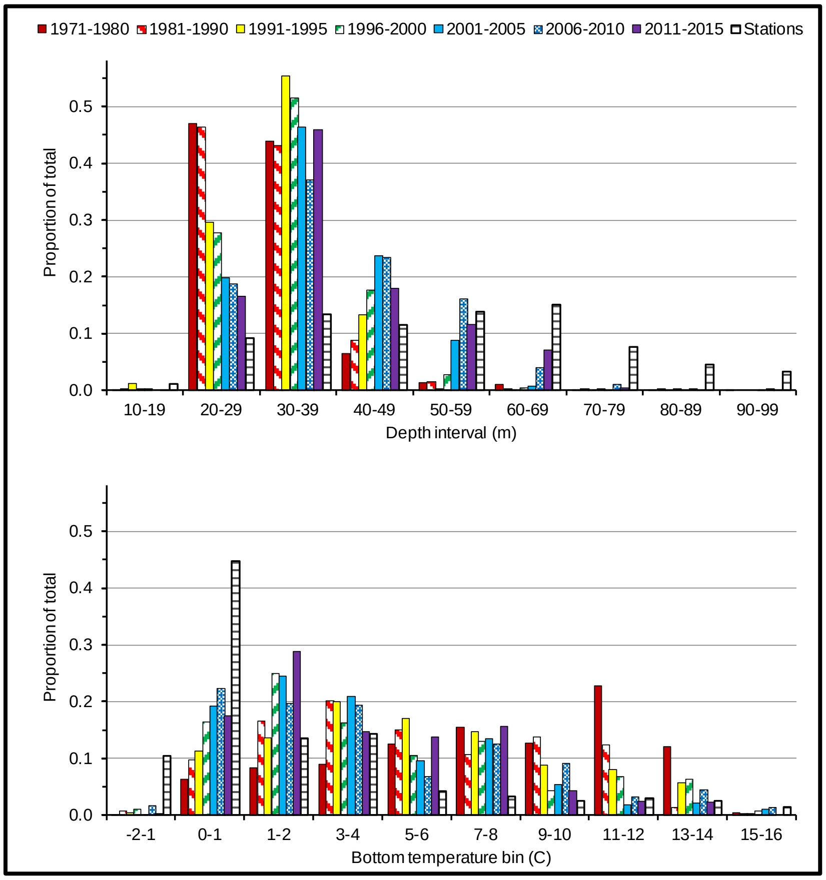


Figure 11. Proportion by depth (top panel) and temperature (bottom panel) categories of total catches of Yellowtail in the RV survey in the southern Gulf of St. Lawrence, 1971 to 2015. Also shown is the proportion of total survey stations versus depth and temperature. About 50% of the stations are situated at depths greater than 100 m.

Population Modelling

Methods

A length-based age-structured model was developed to examine the dynamics and status of Yellowtail. Abundance at age was mapped into the two length groups used for the survey indices and the catch proportions based on length-at-age data. Fish aged 1-3 years were assigned to the < 25 cm length group, those aged 5 years and older were assigned to the ≥ 25 cm length group, and half the 4 year olds were assigned to each length group. Data inputs included: (1) total annual landings in tonnes, (2) annual abundance indices from the September RV survey for two length groups (< 25 cm, ≥ 25 cm), (3) the proportion of the annual landings (in numbers of fish) by length group, (4) the average weight of individuals by length group for the annual fishery catch and the annual survey indices, (5) the annual mean weights at age, and (6) the annual vector of proportions mature at age. Catchability-at-age to the RV survey was also modelled using a logistic curve for selectivity at age multiplied by fully-recruited catchability (q). An informative prior for q (mean = 0.3) was used in the model based on the estimate of catchability of flatfish (plaice) measuring 30 to 35 cm in length to survey trawls as reported by Harley and Myers (2001). The years included 1985 to 2015. Earlier years were omitted due to a lack of reliable fishery catch data. Natural mortality (M) was estimated separately for five time blocks (6-year blocks between 1985 and 2008 and a final 7-year block) and two age groups (1-3 and 5-8+). *M* of 4-year olds was assumed to be the average of *M* for ages 1-3 and 5-8+ in the same year.

Results

The model fit the abundance indices fairly well though the small fish index tended to be underestimated in recent years. The fits to the length group proportions in the fishery catches were good, except for a tendency to slightly overestimate the contribution of large fish to the fishery catches in the early to mid 2000s. The estimated catchability to the RV survey was near zero for age 1 fish (0.008), increasing to 0.25 by age 8+.

Uncertainty in abundance estimates was high, especially for the youngest age group (Fig. 12). The median estimate of abundance of 1-3 year olds increased steadily from about 600 million in 1985 to a peak of 1.3 billion in 2012, i.e. about double the initial abundance. The median estimate of abundance for four and five year olds was about 70 million in the 1980s, increasing to an average value of 350 million since 2000. The median estimate of 6+ abundance was about 100 million in the mid 1980s, decreasing to 11 million in 2014, representing a 90% decline over the time series.

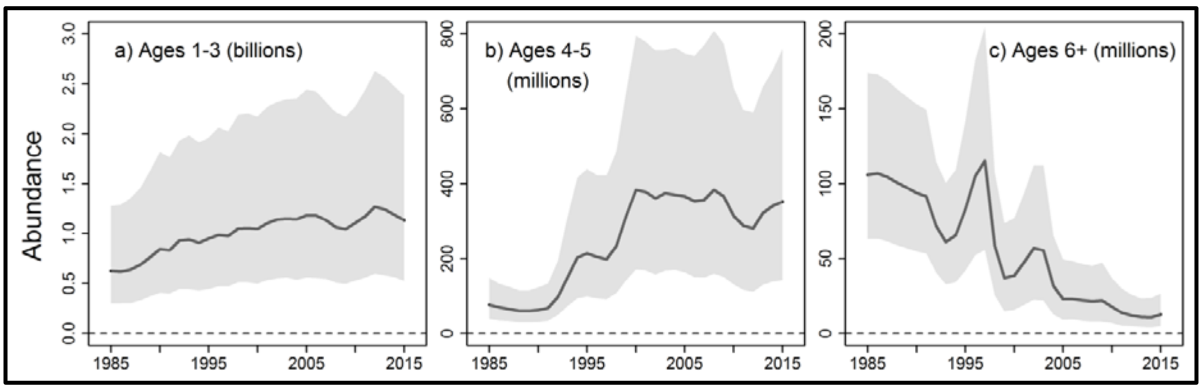


Figure 12. Estimated abundances of three age-groups of Yellowtail flounder in the southern Gulf of St. Lawrence, 1985 to 2015. Lines show the median values and shading their 95% confidence intervals.

The median estimate of spawning stock biomass (SSB) was 55 to 60 thousand t in the 1980s, increasing to a 110 thousand t in the early 2000s and then declining slightly to 75 to 90 thousand t (Fig. 13). Uncertainty in the estimates of SSB was also high. The composition of the SSB is estimated to have changed dramatically since the mid 1980s. Fish 7 years and older were estimated to have contributed 40% of the SSB in 1985 to 1990, declining to less that 0.5% of the SSB since 2013. In contrast, the estimated contribution of 3 and 4 year old fish to the SSB increased from 27% in the 1980s to 59% since 2000. Large Yellowtail (≥ 25 cm) comprised 64% of the SSB during 1985 to 1989 but declined to 28% of the SSB over the period 2011 to 2015.

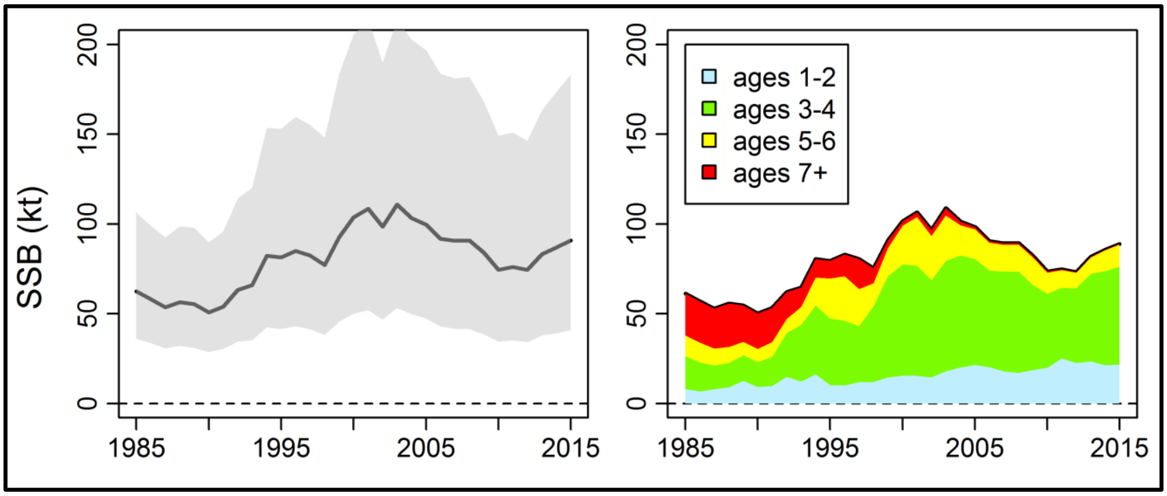


Figure 13. Estimated spawning stock biomass (SSB) of Yellowtail flounder in the southern Gulf of St. Lawrence (left panel) and its estimated age composition (right panel), 1985 to 2015. In the left panel, lines show the median estimate and shading its 95% confidence interval.

Large changes in estimated natural mortality (*M*) occurred over the time series with *M* for young fish (ages 1-3) declining from 0.76 (53% annual mortality) during 1985 to 1990 to 0.17 to 0.23 (16% to 21% annually) since 1997 (Fig. 14). In contrast for older fish (aged 5 years and older), the median estimate of *M* during 1985 to 1990 was 0.25 (22% annually) and increased to 1.99 (86% annual mortality) in 2009 to 2015.

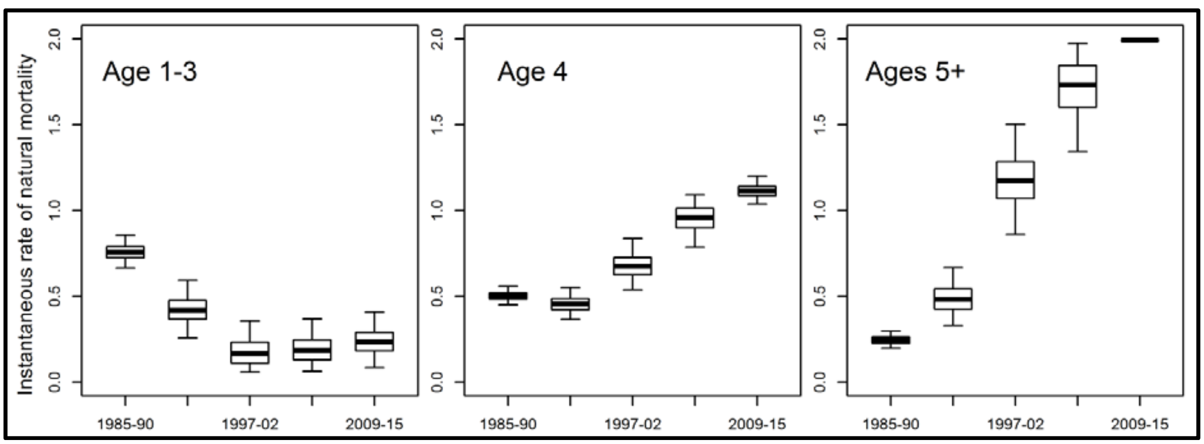


Figure 14. Estimated natural mortality of three age groups of Yellowtail flounder during five time periods in the southern Gulf of St. Lawrence, 1985 to 2015. Horizontal lines show the median, boxes the interquartile range (25 to 75 percentiles) and error bars the 95% confidence interval.

Fishing mortality (*F*) is estimated to be very low with median values < 0.003 on the younger ages (up to age 4) and size groups (<= 25 cm) (Fig. 15). For Yellowtail aged 6 and older, estimated *F* was highest during 1997 to 2008 and then declined to an average of about 0.005.

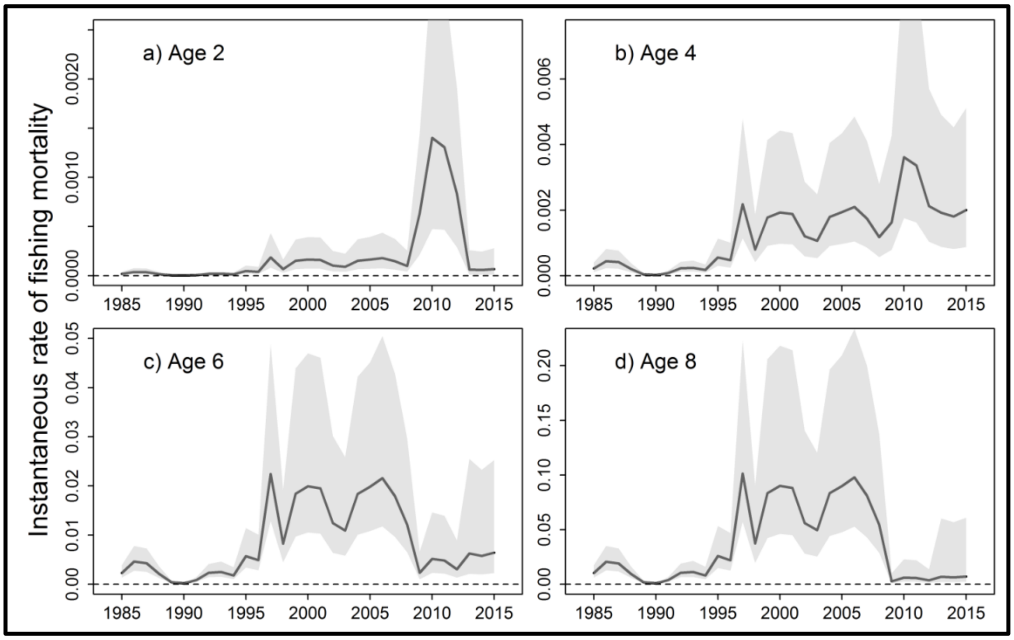


Figure 15. Estimated fishing mortality of four ages of Yellowtail flounder in the southern Gulf of St. Lawrence, 1985 to 2015. Solid lines and shading indicate the median and 95% confidence interval based on MCMC sampling.

Projections Relative to Different Catch Options

The population was projected forward five years assuming current productivity conditions would persist over the projection period. Natural mortality was set at the levels estimated for the 2009 to 2015 time block. For each year and resampling iteration, population weights at age, average individual weights in the fishery catch by length group, and recruitment rates were randomly sampled from the estimated values in the last ten years. Projections were conducted at three levels of annual fishery catch: 0 t, 100 t and 300 t.

Fishing mortality is a very small proportion of the total mortality of Yellowtail in the sGSL. Projections at catch levels of 0 t, 100 t, and 300 t show no perceivable difference in stock trends over the next five years. Estimated SSB declined slowly but steadily over the projection period even with no fishery catch (Fig. 16). The decline was negligibly greater with catches of 100 t and slightly greater with catches of 300 t. As in the historical period, uncertainty in the level of SSB was great during the projection period. At the scale of the sGSL, natural mortality appears to be the dominant factor affecting stock status.

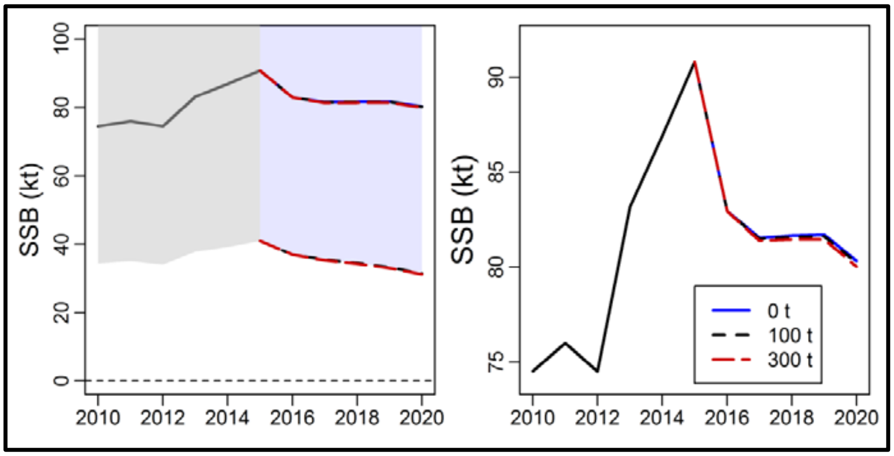


Figure 16. Projected (2016 to 2021) SSB (kt) of southern Gulf of St. Lawrence Yellowtail flounder at three levels of annual fishery catch, 2016 to 2021. Black lines show historical estimates and coloured lines show projected estimates (median). Grey and blue shading show the 95% confidence intervals for the historical period and the projection period with no catch, respectively. Dashed lines indicate the lower confidence limit for projections with fishery catches of 100 or 300 t. The right panel is a close-up of the left panel, showing median values of SSB.

Reference Points for Yellowtail Flounder from NAFO Div. 4T

In the absence of an acceptable surplus production model or stock and recruitment model to derive reference points, a proxy for B_{msy} representing the abundance of Yellowtail (≥ 25 cm) during a productive period is used (DFO 2009). The productive period is chosen as the period from 1977 to 1997 when the RV survey index fluctuated at an average level of 2.64 kg per tow (Fig. 17). The lower reference point (B_{lim}) is chosen as 40% of the proxy value for B_{msy}, equal to 1.06 kg per tow. The upper stock reference point (B_{usr}) value of 80% B_{msy} equals 2.12 kg per tow. The annual abundance index for adult sized Yellowtail has been below B_{lim} since 2006. In 2015, the abundance index was 61% of B_{lim} (Fig. 17).

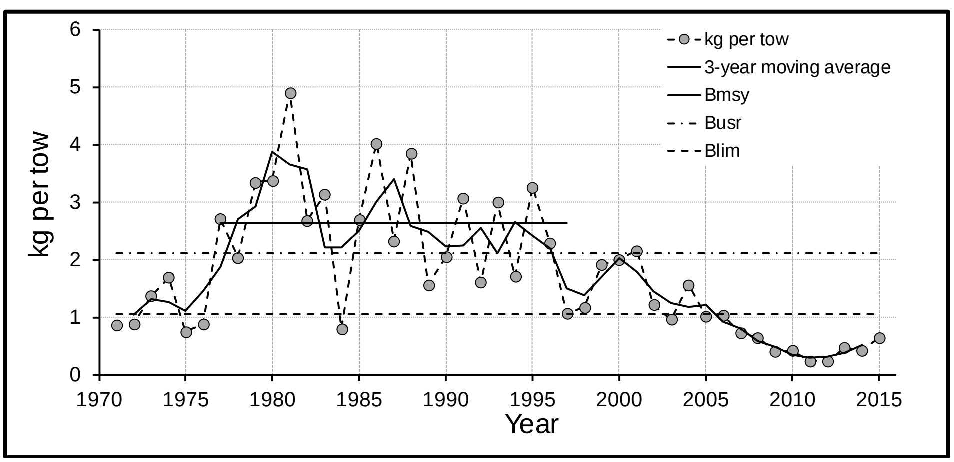


Figure 17. Research vessel survey biomass index (kg per tow) and corresponding proxy values for B_{msy}, B_{usr}, and B_{lim} of large (≥ 25 cm) Yellowtail flounder from the southern Gulf of St. Lawrence, 1971 to 2015.

Sources of Uncertainty

The age-structured length-based model assumed the same correspondence of ages over the length groups from 1985 to 2015. Supposing a systematic change in size at age over time, there would a subsequent bias in the age distributions within those size groups. If size at age had decreased over time, the use of a constant age at length distribution could be confused with the estimated changes in natural mortality.

There has been intermittent sampling for age and determination of size at age and age structure of the Yellowtail stock in the southern Gulf. Any changes in size at age over time may not detectable with the information available.

Since 2014, there is mandatory sorting and discarding of Yellowtail less than 23 cm in the commercial fishery of the Magdalen Islands. The effect of this change in fishery management from 2014 forward would be most important on the fishery selectivity parameters of the model that are used in the projections. Currently, such an effect is not accounted for. In addition, the survival rates of discarded fish are not known. If the annual TAC is based on landed catch only, then loss from discard mortality is not accounted for in the assessment of impacts of fisheries activities on the stock.

There is clear evidence of a sustained decline in the size at maturity of Yellowtail in the sGSL. There is uncertainty regarding the reproductive value of the SSB for different ages and sizes. In other species, there is a clear association between reproductive potential and fish size, and in some cases, age and spawning history of the spawners and its effect on productivity,

There are uncertainties associated with the maturity staging practices in the survey which can impact the perception of variations in size at maturity. It is difficult to distinguish immature from resting stages of fish at small sizes during September when sampling occurs. Validation of maturity staging criteria could be considered using histology, to assess the extent of the uncertainty from field maturity staging.

There have generally been uncertainties with the completeness of the landings data. Prior to the initiation of the experimental bait fishery in the Magdalen Islands, there was dockside monitoring with bycatch restrictions which provided good landings data. The bait fishery, when it operated, was self-reporting through logbooks. Presently, the commercial fishery has mandatory 100% dockside monitoring.

CONCLUSIONS AND ADVICE

Yellowtail flounder is currently caught in relatively small directed fishery with landings less than about 200 t over the past 14 years. It is primarily concentrated around the Magdalen Islands and supplies the local bait market. Despite a minimum size limit of 25 cm, the proportion of sampled catches that is less than 25 cm has increased rapidly from less than 20% before 2000 to a peak of 75% in 2010. This proportion declined slightly, to less than 40% in the past three years.

There has been a decrease in the modal length of Yellowtail in the southern Gulf of St. Lawrence. Abundance indices from the RV survey in September show that small (< 25 cm) Yellowtail abundance has increased whereas large (≥ 25 cm) Yellowtail abundance has declined. The proportion of small fish (< 25 cm) in survey catches (in numbers) has increased from less than 10% before 1990 to almost 89% by 2011, but decreased slightly to 59% in 2015. This identical pattern of abundance and size distribution was also observed for the survey strata around the Magdalen Islands.

Natural mortality on larger and older Yellowtail is estimated to have increased from 22% annual mortality during 1985 to 1990 to 86% in 2009 to 2015. In contrast, natural mortality on small and young Yellowtail is estimated to have declined from 53% annually in 1985 to 1990 to 16% to 21% annually since 1997.

Although SSB is estimated to be higher in the past decade than in the mid to late 1980s, the proportion of the SSB composed of larger and older (7+ years) fish has declined from 40% in 1985 to 1990 to less that 0.5% since 2013. The estimated contribution of 3 and 4 year old fish to the SSB increased from 27% in the 1980s to 59% since 2000.

Fishing mortality is estimated to generally be very low, for both size groups and for most ages and years. Fishing mortality is such a small proportion of the estimated total mortality of Yellowtail that there is no perceived difference in stock trends over the next five years at catch projections of 0 t, 100 t, and 300 t annually.

A limit reference point for this stock (B_{lim} = 1.06 kg per tow) was derived from the commercial sized (≥ 25 cm) biomass index from the RV survey. Based on this index, the stock decline began in 1998 and the index reached the lowest value of the time series in 2012. The stock has been in the critical zone since 2006. The abundance index in 2015 was 61% of B_{lim}. The estimated SSB from the model indicates that it has not changed like the large Yellowtail index used to define the reference point. However, the SSB is now composed primarily of fish less than 25 cm representing 72% of the total SSB during 2011 to 2015 compared to 36% during 1985 to 1989. This is an important consideration as there is an assumed greater value to reproductive potential of larger animals in the population.

The contraction in size structure of Yellowtail flounder, the decline in the estimated size at 50% maturity from 23 to 24 cm in the 1970s to 12 to 13 cm in recent years, and the decline in abundance indices of the previously abundant commercial sized group are consistent with a stock experiencing very high levels of mortality. At the scale of the southern Gulf, natural mortality appears to be the dominant factor affecting stock status. The causes of the high natural mortality are not fully known but available evidence supports the hypothesis that predation by grey seals is a major component of this increased natural mortality.

OTHER CONSIDERATIONS

Stock Status Indicators

Commercial-sized Yellowtail flounder are defined as fish measuring 25 cm and longer. The three-year moving average of the RV survey biomass indices for commercial-sized Yellowtail will be used as the indicator of stock status in the interim years of the multi-year management cycle. This index will be compared to the LRP value, which is on the scale of the RV survey index. An assessment before the scheduled five-year cycle could be undertaken if the three-year moving average of the RV survey biomass index for Yellowtail ≥ 25 cm exceeds the LRP value (1.06 kg per tow). In 2015, the RV survey biomass index for Yellowtail ≥ 25 cm was 61% of the LRP.

An interim year update will be provided mid-way in the five-year assessment cycle, i.e. in early December 2018, to allow sufficient time to complete a full assessment and plan the peer review if the indicators signal that a re-assessment is warranted in the winter 2019.

SOURCES OF INFORMATION

This Science Advisory Report is from the February 29 and March 1, 2016 science peer review meeting on the Stock assessment of Yellowtail Flounder (*Limanda ferruginea*) of the southern Gulf of St. Lawrence (Northwest Atlantic Fisheries Organization (NAFO) Division 4T). Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

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MPO. 2016. Évaluation du stock de limande à queue jaune (Limanda ferruginea) du sud du golfe du Saint-Laurent (Division 4T de l'OPANO) jusqu'en 2015. Secr. can. de consult. sci. du MPO, Avis sci. 2016/033.